Sounding Rocket Briefing

Structure and Evolution of the Universe Subcommittee

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Astronomical Search for Origins and Planetary Systems Subcommittee

NASA Sounding Rocket Program

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NASA Sounding Rocket Program

- Unique opportunities for Low Cost, Fast-turnaround, Focused Scientific Research
- Platforms in space for Testing and Developing New Technology
- "Hands on" training for young researchers and engineers

Sounding Rockets provide NASA with a new generation of explorers

How does the Program work?

- Program serves a broad range of scientific disciplines at NASA whose missions are selected based on peer-reviewed proposals:

  Astronomy Solar

  Planetary Geospace

- Program implementation involves a strong three-way partnership:

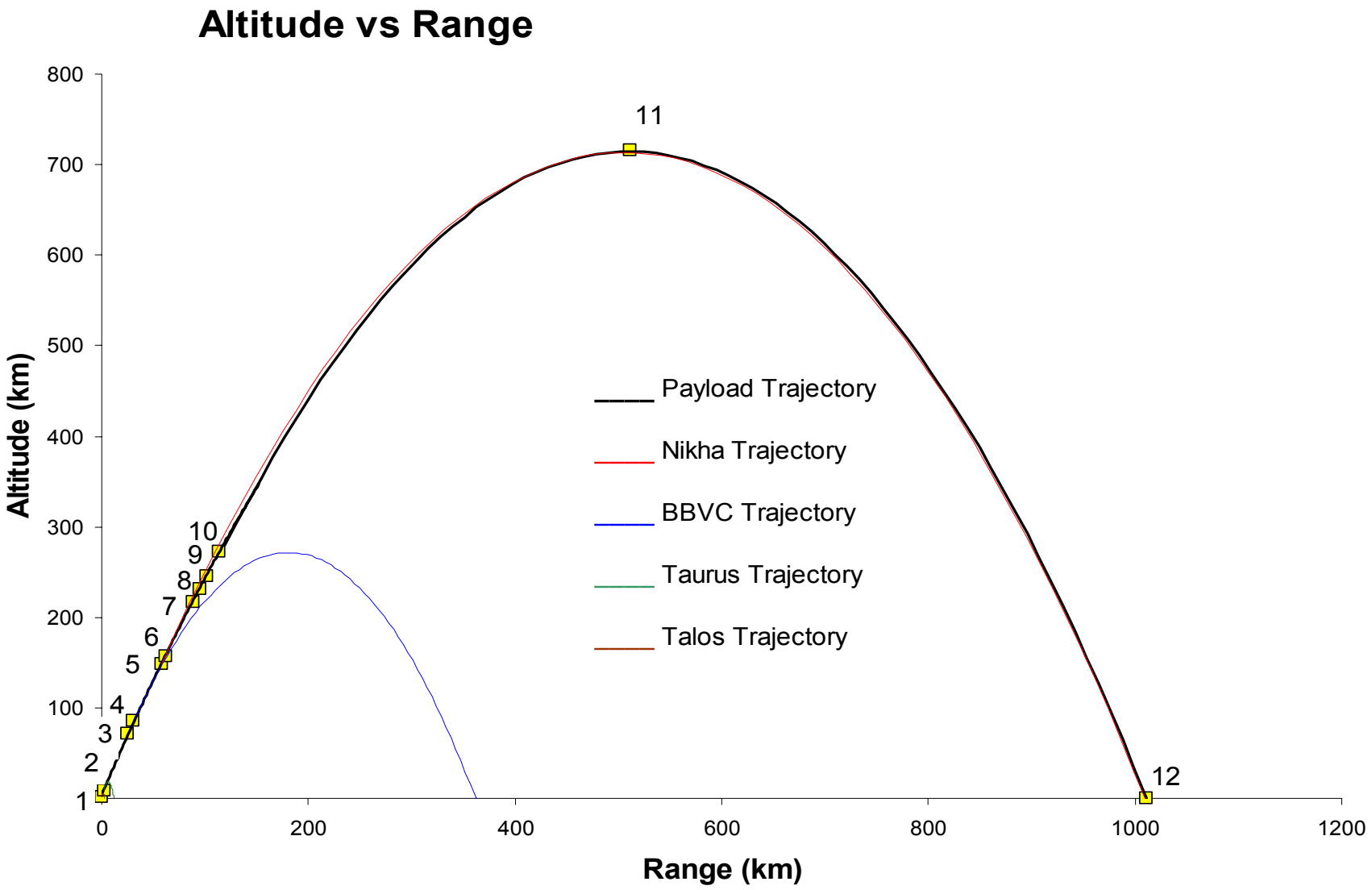
  Principal Investigator • Wallops Flight Facility • NASA HQ

- P.I. initiates and leads the mission, from proposal to instrument design to the data analysis and publication of results.

Sounding Rocket Users

- Astronomy / Planetary / Solar
  - Telescopes with fine-pointing (< arc second); Option for joy-stick positioning; Ability to look at objects (comets, Mercury, Venus) close to the sun; Recovery and re-flights are standard.
- Geospace
  - In-situ measurements into “targets” (e.g., aurora, cusp, thunderstorms, gravity waves, noctilucent clouds)
- Microgravity
  - Long periods of “zero-G” relative to airplanes and drop towers with extremely low disturbances
- Special Engineering Projects
  - (e.g., Aerobraking)

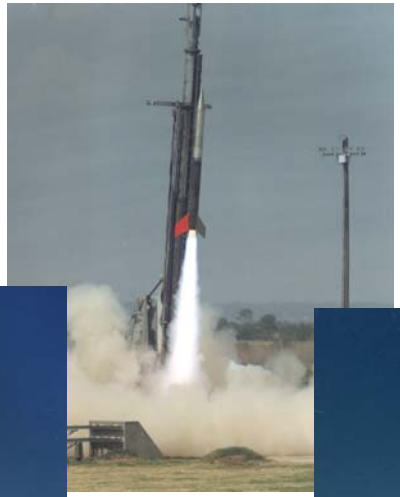
Typical Flight Profile



Sounding Rocket Vehicles

Terrier Malemute

Nike Orion



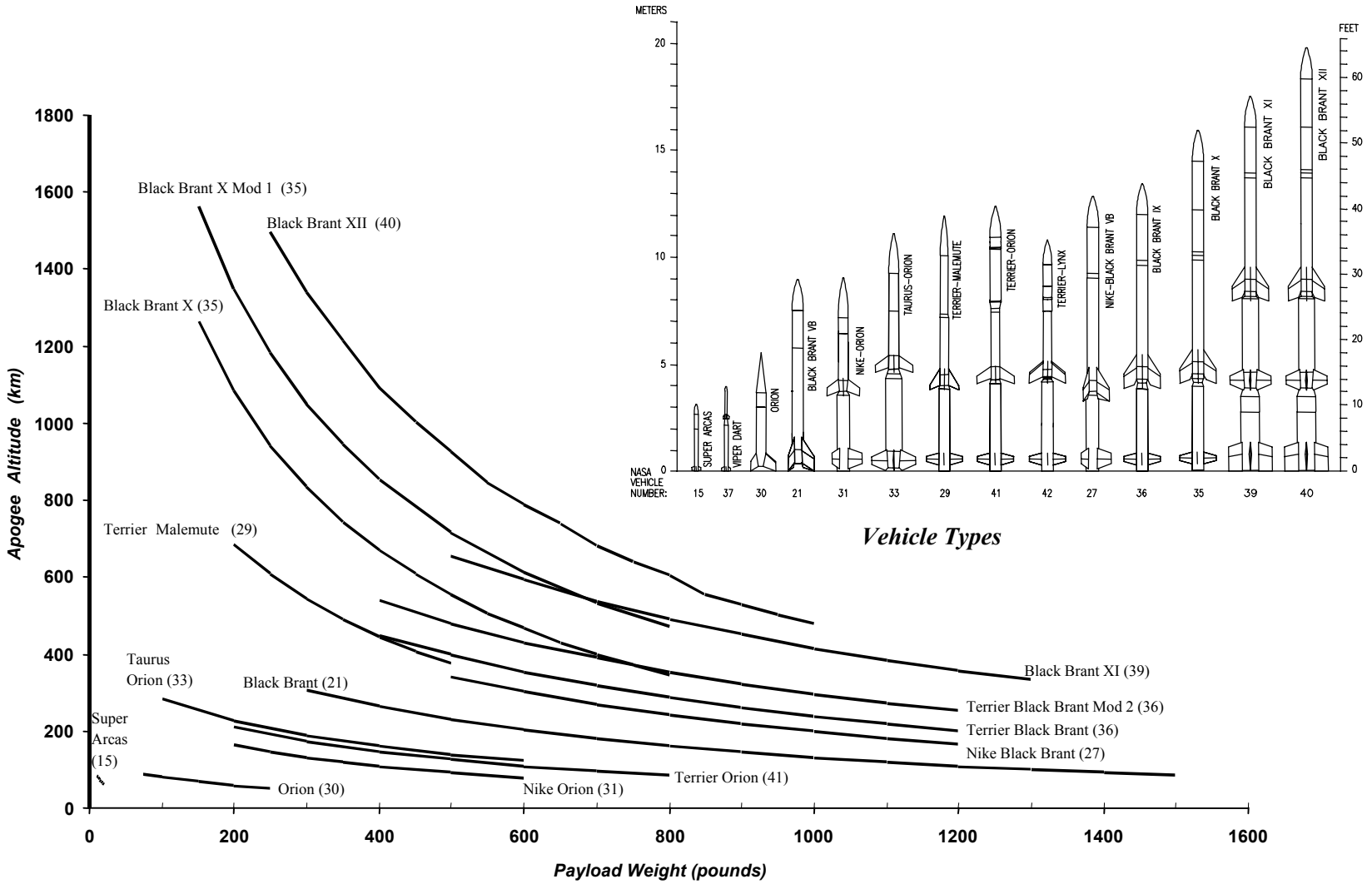
Orion

Terrier Orion

Black Brant IX

Black Brant XII

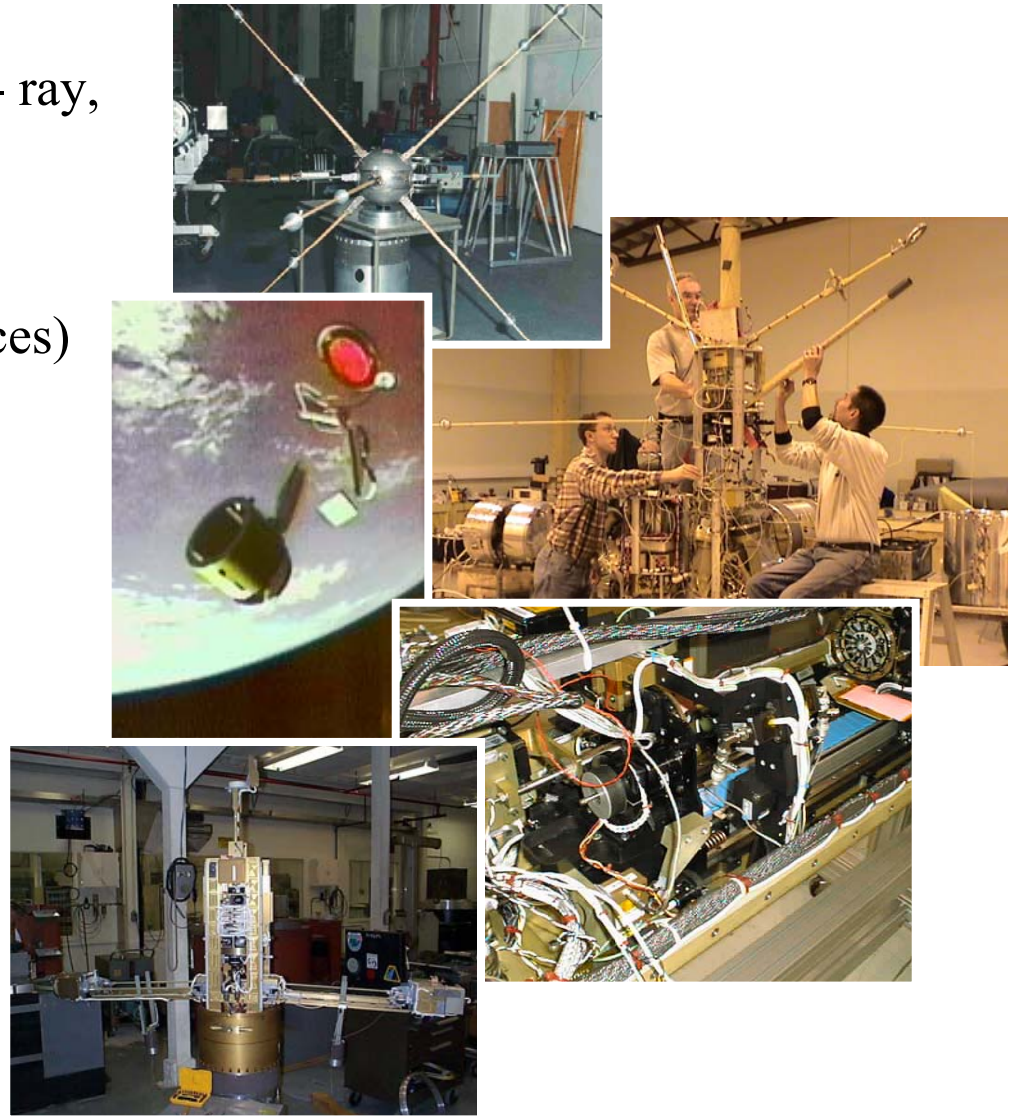
Sounding Rocket Vehicle Family



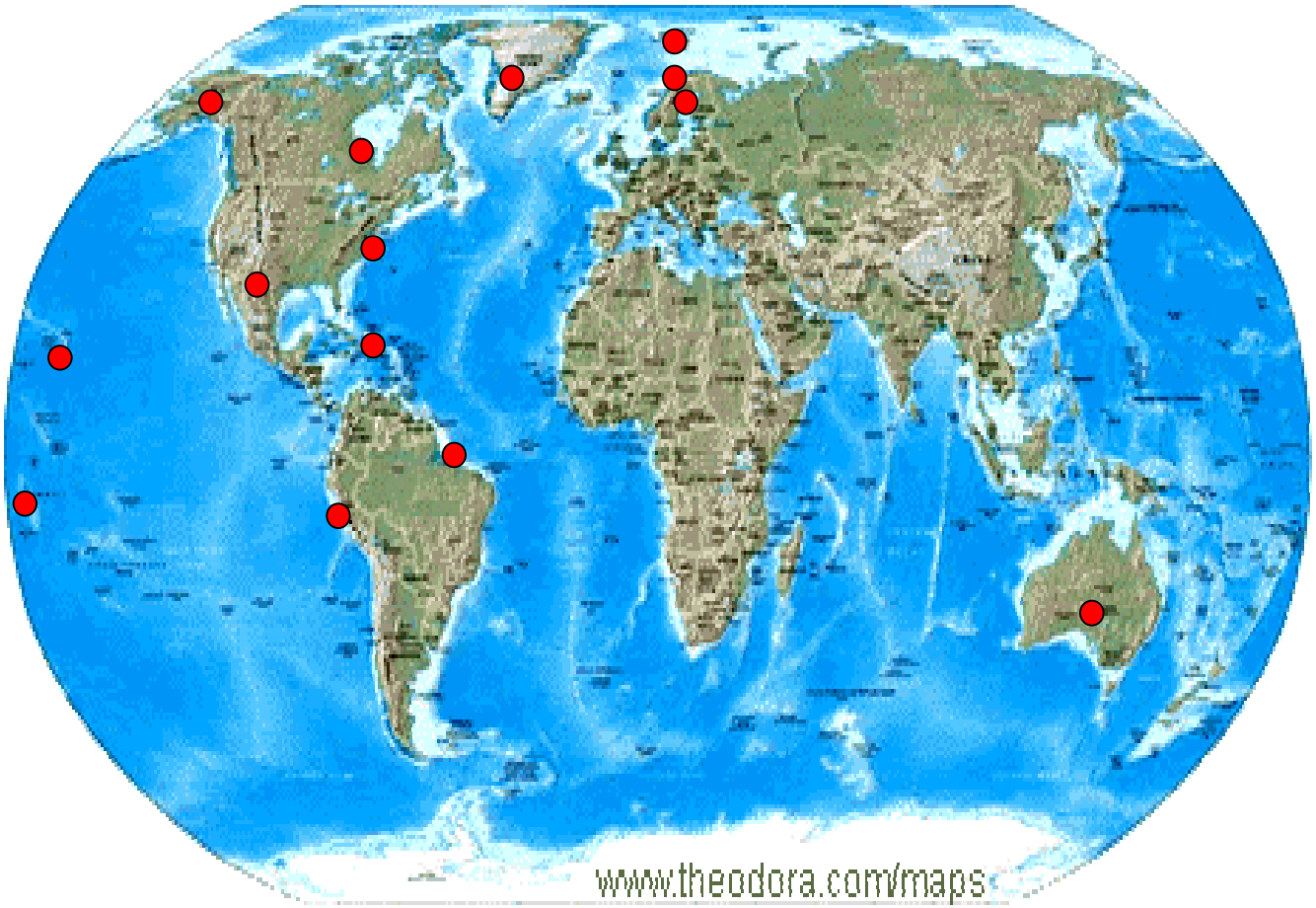
Experiments

- Astronomy (UV, X-ray, Gamma- ray, Visible, etc)
  - Spectroscopy
  - Polarimetry
- Plasma Physics (Geospace sciences)
  - Particle Detectors
  - E-field Booms
  - Magnetometers
- Microgravity
- Air Sampling
- Atmospheric Entry Vehicles

Many payloads include multiple sub-payloads and 2 or more high rate telemetry links



Launch Sites

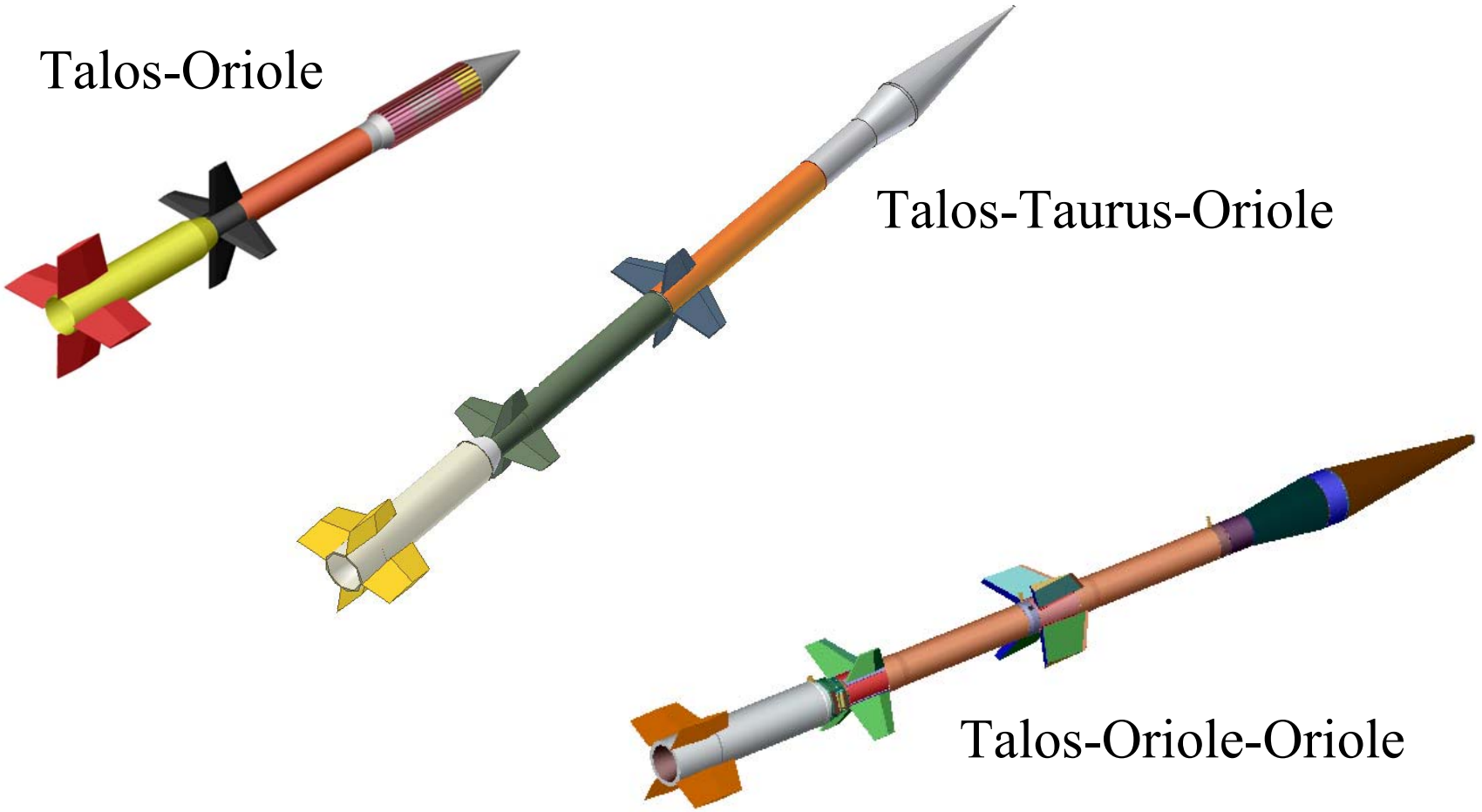


Map provided by www.theodora.com w/ permission

Near-term and Long-term Capability Expansion

- Oriole Configurations
  - Intermediate enhancement of capabilities
  - Relatively low-risk
  - Development underway
    - Leveraging multiple sources for funding
- High Altitude Sounding Rocket
  - Large step in increased capability
  - Off-the-shelf hardware to be used
    - Minimize cost
    - Minimize risk
    - Minimize development time

Expansion of "Conventional" Vehicle Capabilities



Oriole-based Vehicles

- Can accommodate 30” diameter payloads
  (possibly larger depending on gravimetrics)
- Talos-Oriole
  - 800 lbs (30”): 450 km apogee
  - 900 lbs (30”): 400 km apogee
  - 1000 lbs (30”): 380 km apogee
- Talos-Oriole-Oriole
  - 800 lbs (30”): 700 km apogee
  - 900 lbs (30”): 650 km apogee
  - 1000 lbs (30”): 560 km apogee

The Next Step…

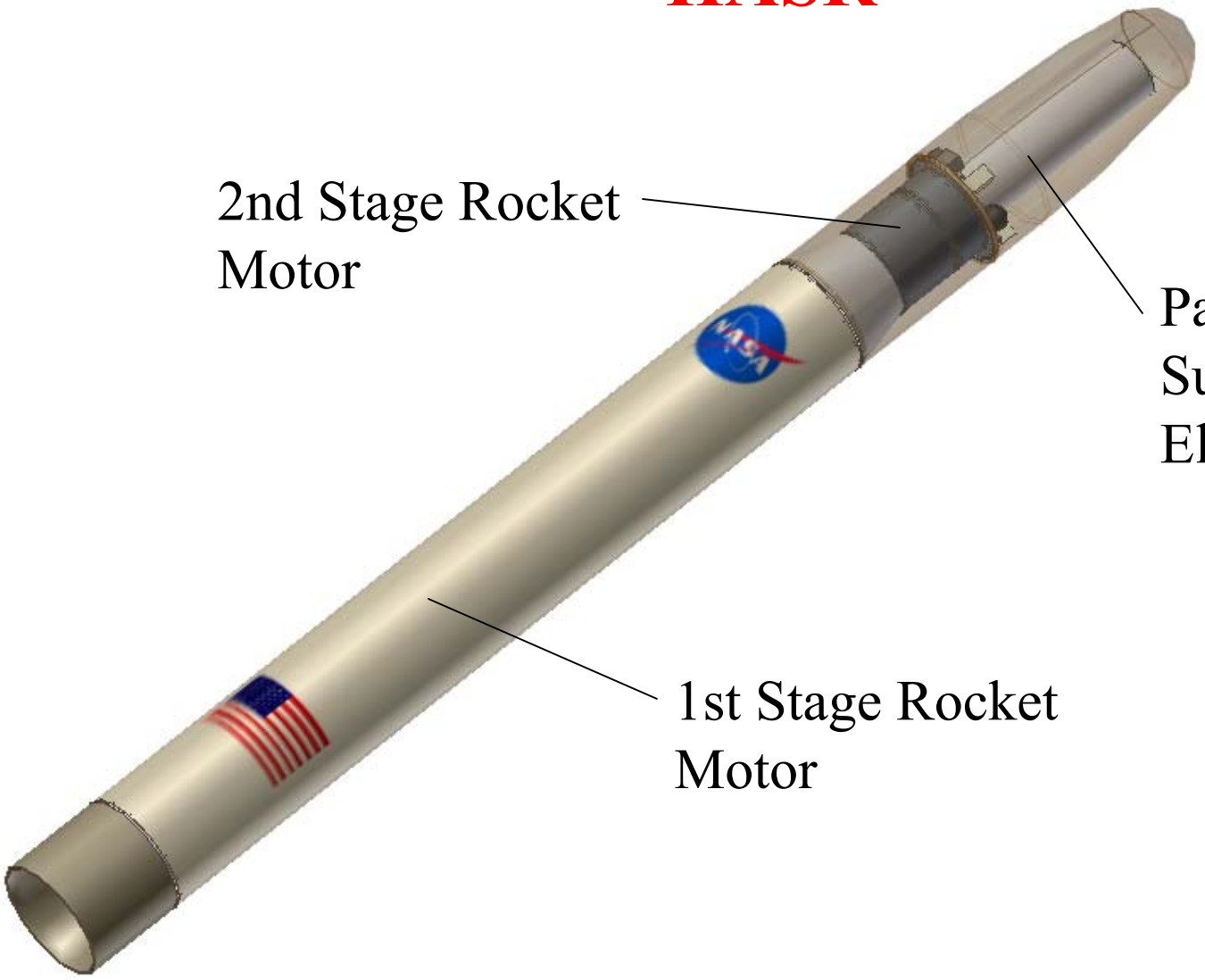
High Altitude Sounding Rocket

(HASR)

- Total Payload Wt: 1000 lbs
- Science Instrument Wt: 700 lbs
- Payload Diameter: 50 in.
- Apogee Altitude: 3400 km
- Observation Time: ~40 minutes

Note: All numbers preliminary

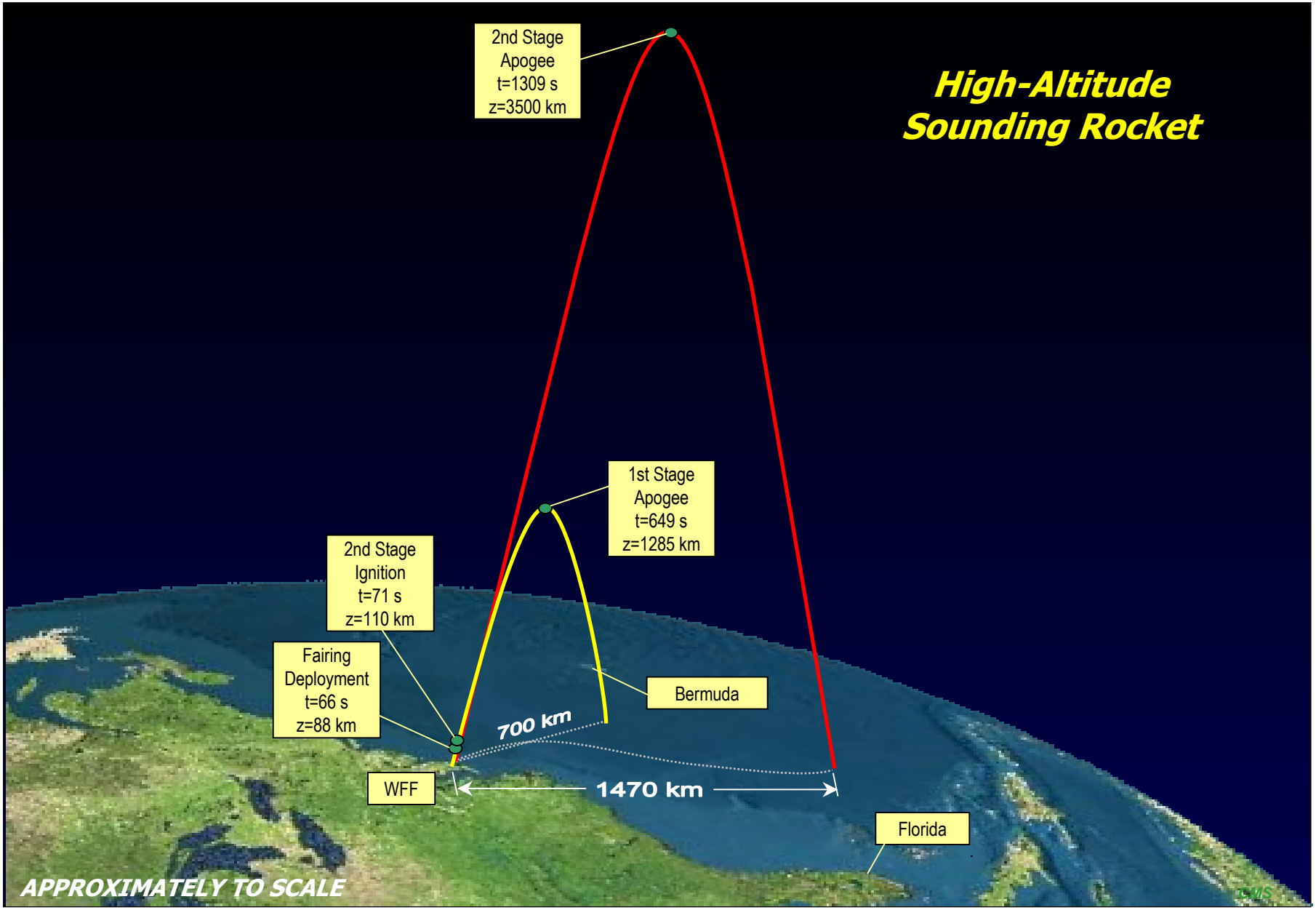
HASR


2nd Stage Rocket Motor
Payload and Support Electronics
1st Stage Rocket Motor

HASR

Conceptual view of HASR on the Virginia Spaceflight Center launch pedestal

Fairing Deployment at T+ 66 seconds

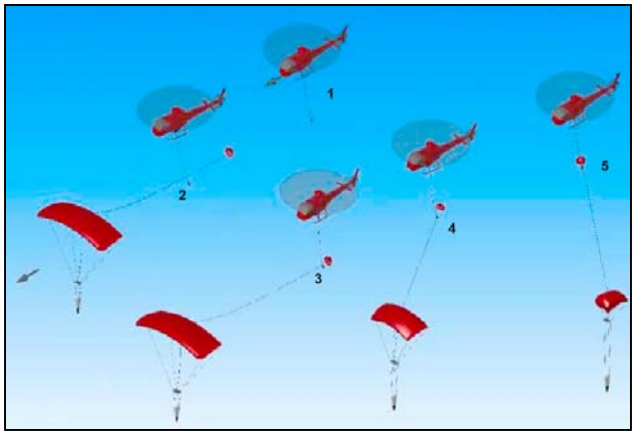

High-Altitude
Sounding Rocket
2nd Stage
Apogee
t=1309 s
z=3500 km
1st Stage
Apogee
t=649 s
z=1285 km
2nd Stage
Ignition
t=71 s
z=110 km
Fairing
Deployment
t=66 s
z=88 km
Bermuda
700 km
WFF
1470 km
Florida
APPROXIMATELY TO SCALE

Relative Vehicle Performance

Vehicle	PL Diameter	PL Weight	Apogee	Time above 100 km
Terrier-Brant (2 stg) (Existing Capability)	18 in	1000 lbs	300 km	7 min
Talos-Oriole	30 in	1000 lbs	380 km	8 min
Black Brant XII (3 stg) (Existing Capability)	18 in	1000 lbs	465 km	9 min
Talos-Oriole-Oriole	30 in	1000 lbs	560 km	10 min
High Altitude Sounding Rocket	50 in	1000 lbs	3400 km	40 min

Other Technologies w/ Potential Application to Future HASR Mission

- Air Retrieval
  - Fly more missions from Wallops
  - Potential for recovering HASR payloads
- High Energy Decelerators
  - Utilize inflatable aeroshell concepts
  - Provides initial deceleration at high Mach numbers



Benefits of the HASR

1) Longer observation times (up to 40 minutes)
2) Larger apertures (>1 meter)
3) Affordable access to space
4) Short mission development time (concept-to-flight <3 years?)
5) Provides trained students, maintains proficiency and expands capability in space-based astronomical technology - especially in uncertain times
6) Can mitigate development risk for complex systems (e.g. adaptive optics wave-front correction for thin mirrors, segmented mirror deployment or formation flying interferometers) with zero-g flight tests.
7) Can "cherry pick" new discovery space, because a factor of >10 increase in sounding rocket-borne telescope sensitivity.

New Science with the HASR

Astronomy / Planetary / Solar

- Increased "hang time" of 40 minutes and larger diameter (~ 1 m) telescopes will provide greater sensitivity and higher angular resolution (e.g., to observe extra galactic and other faint objects)
- Longer observing times introduce:
  - -- Larger number of targets on a given flight
  - -- Temporal evolution of solar phenomena
  - -- New class of experiments: IR observations (payload has time to cool down)
- Provide observational capabilities not available on Hubble (e.g., different bypass, observe objects near the sun, etc.)
- Mitigate development risk for complex systems (e.g., adaptive optics wave-front correction for thin mirrors, segmented mirror deployment) in zero-G flight tests.

New Science with the HASR

Geospace

- Penetrate the Aurora and Cusp Acceleration Regions (> 2500 km)
- Observe high altitude regions with constellations of well-instrumented payloads
- Observe physics of resonances, Alfvén waves, and other phenomena with periods of 10's of minutes
- Study inner radiation belt

Microgravity

- Combustion experiments of considerably longer periods enable new class of experiments and applications.

HASR Development Status

- 20+ vehicle configurations have been assessed
- Prime configuration has been identified
- Formulation team is refining schedule and cost details
- Informational discussions have begun with the potential hardware vendor
- Budget assessment is underway to establish time frame for developmental effort and 1st demonstration flight
- Costs:
  - Development is roughly $ 6M
  - Expected cost per mission when operational: $ 5M.

Seek input/support from Science Advisory Committees